INDOOR AIR QUALITY ASSESSMENT

Halifax Elementary School
Silver Lake Regional School District
464 Plymouth Street
Halifax, Massachusetts

Prepared by:
Massachusetts Department of Public Health
Bureau of Environmental Health Assessment
April, 2002

Background/Introduction

At the request of Cathy Drinan of the Halifax Health Department and Principal Diane Biggieri, the Massachusetts Department of Public Health (MDPH), Bureau of Environmental Health Assessment (BEHA) provided assistance and consultation regarding indoor air quality issues at the Halifax Elementary School in Halifax, Massachusetts. Concerns regarding water damage and possible microbial growth in the school library due to a plumbing leak prompted this request.

On January 11, 2002, Cory Holmes, Environmental Analyst of the Emergency Response/Indoor Air Quality (ER/IAQ) program, BEHA, conducted an indoor air quality assessment. Joe Klaus, School Custodian, accompanied Mr. Holmes during the assessment.

The school is a multi-level brick building, with both wood and vinyl siding, originally built on a cement slab in 1959. School renovations, including an addition, were made in 1994. The upper level consists mainly of general classrooms. The lower level is made up of general classrooms, a library, an art room, a music room, kitchen and cafeteria, offices, a gymnasium and an all purpose room, which formally served as the auditorium. The school is physically attached to the Holmes Public Library. Windows in the school are openable.

Methods

Air tests for carbon monoxide, carbon dioxide, temperature and relative humidity were taken with the TSI, Q-Trak, IAQ Monitor, Model 8551. Moisture content in the interior lining of the rooftop air handling unit (AHU) was measured with a Delmhorst, BD-2000 Model, Moisture Detector with a Delmhorst Standard Probe.

Results

This elementary school houses pre-kindergarten through grade 4, with a student population of approximately 720 and a staff of approximately 80. Tests were taken under normal operating conditions and results appear in Tables 1-4.

Discussion

Ventilation

It can be seen from the tables that carbon dioxide levels were elevated above 800 ppm (parts per million) in fifteen of twenty-eight areas surveyed, indicating a ventilation problem in these areas of the school.

Fresh air in classrooms is supplied by a unit ventilator (univent) system (see Picture 1). Univents draw air from outdoors through a fresh air intake located on the exterior walls of the building (see Picture 2) and return air through an air intake located at the base of each unit. The mixture of fresh and return air is drawn through a filter and heating coil, and is then expelled from the univent by motorized fans through fresh air diffusers on the top of each unit (see Figure 1).

Univents were deactivated or inoperable in a number of classrooms surveyed. Several univents were reportedly deactivated at the request of occupants due to excessive heat production, which may indicate a problem with fresh air intakes or thermostatic control. The univent in classroom 125 was reportedly inoperable due to a fuse problem. The univent in classroom 115 lacked essential mechanical components that were removed to repair other units (see Picture 3). To function properly, univents must be activated and allowed to operate during school hours.

Obstructions to airflow, such as books, papers and posters on top of univents, and bookcases, tables and desks in front of univent returns, were seen in a number of classrooms (see Picture 4). The fresh air intake for classroom 204, which is above the library office, was sealed with plywood (see Picture 5). To function as designed, univents and univent returns must remain free of obstructions.

Ventilation in the gymnasium, cafeteria and offices is provided by rooftop or ceiling-mounted air handling units (AHUs). The ceiling-mounted AHU in the cafeteria appears to be lacking ductwork, which prevents proper distribution of air throughout the cafeteria (see Picture 6).

The mechanical exhaust ventilation system consists of vents installed in cabinets, classroom walls or in the ceilings of coat closets. Exhaust vents were not functioning in a number of classrooms, which can indicate that exhaust ventilation was deactivated, or that rooftop motors were not functioning. As with the univents, a number of exhaust vents were obstructed by coats, boxes and other items (see Pictures 7 & 8), particularly the vents located in coat closets. The placement of storage shelves allows the vents to be easily blocked with stored materials. Exhaust vents in several restrooms and in the art room storage room were also not operating.

To maximize air exchange, the BEHA recommends that both supply and exhaust ventilation operate continuously during periods of school occupancy. Without the HVAC system operating as designed, normally occurring pollutants cannot be diluted or removed, allowing them to build up and lead to indoor air quality/comfort complaints. In order to have proper ventilation with a univent and exhaust system, the systems must be balanced to provide an adequate amount of fresh air to the interior of a room while removing stale air from the room. The date of the last balancing of these systems was not

available at the time of the assessment. It is recommended that HVAC systems be re-balanced every five years (SMACNA, 1994).

The Massachusetts Building Code requires a minimum ventilation rate of 15 cubic feet per minute (cfm) per occupant of fresh outside air or have openable windows in each room (BOCA, 1993; SBBRS, 1997). The ventilation must be on at all times that the room is occupied. Providing adequate fresh air ventilation with open windows and maintaining the temperature in the comfort range during the cold weather season is impractical. Mechanical ventilation is usually required to provide adequate fresh air ventilation.

Carbon dioxide is not a problem in and of itself. It is used as an indicator of the adequacy of the fresh air ventilation. As carbon dioxide levels rise, it indicates that the ventilating system is malfunctioning or the design occupancy of the room is being exceeded. When this happens a buildup of common indoor air pollutants can occur, leading to discomfort or health complaints. The Occupational Safety and Health Administration (OSHA) standard for carbon dioxide is 5,000 parts per million parts of air (ppm). Workers may be exposed to this level for 40 hours/week based on a time-weighted average (OSHA, 1997).

The Department of Public Health uses a guideline of 800 ppm for publicly occupied buildings. A guideline of 600 ppm or less is preferred in schools due to the fact that the majority of occupants are young and considered to be a more sensitive population in the evaluation of environmental health status. Inadequate ventilation and/or elevated temperatures are major causes of complaints such as respiratory, eye, nose and throat irritation, lethargy and headaches.

Temperature readings ranged from 69^{o} F to 81 ^{o} F, which were outside of the BEHA recommended range in some areas. The BEHA recommends that indoor air

temperatures be maintained in a range of 70 ^{o} F to 78 ^{o} F in order to provide for the comfort of building occupants. As discussed, a number of temperature control complaints were expressed to BEHA staff during the assessment (see Tables), which may indicate that thermostats are malfunctioning and/or may need repair/replacement. In addition, it is difficult to control temperature and maintain comfort without operating the HVAC equipment as designed. In many cases concerning indoor air quality, fluctuations of temperature in occupied spaces are typically experienced, even in a building with an adequate fresh air supply.

Relative humidity measurements ranged from 19 to 51 percent, which were below the BEHA recommended comfort range in most areas sampled.. The BEHA recommends that indoor air relative humidity is comfortable in a range of 40 to 60 percent. Relative humidity levels in the building would be expected to drop during the winter months due to heating. The sensation of dryness and irritation is common in a low relative humidity environment. Low relative humidity is a very common problem during the heating season in the northeast part of the United States.

Microbial/Moisture Concerns

As previously discussed, concerns regarding potential microbial growth from a plumbing leak in the library prompted the indoor air assessment. According to school officials, it was discovered the Tuesday morning after Veteran's Day weekend (November 13, 2001) that a pipe had burst, resulting in water damage to the library and standing water on carpeting. The carpet was reportedly dried using a combination of wet vacuum extraction and fans. Prior to this BEHA assessment, the leak was repaired and remediation had been completed. No existing water stains/damage or associated odors were noted on carpeting, walls or other building materials.

The library office, however, appears to be an area of chronic water penetration unrelated to the burst pipe in the library proper, as evidenced by water damaged building materials. Water penetration through the building envelope in this area was indicated by missing/water-damaged ceiling tiles, musty odors and efflorescence (i.e., mineral deposits) on gypsum wallboard (GW) (see Pictures 9 & 10). Efflorescence is a characteristic sign of water damage to building materials such as brick or plaster, but it is not mold growth. As moisture penetrates and works its way through building materials, water-soluble compounds dissolve, creating a solution. As the solution moves to the surface of the material (e.g., GW), water evaporates, leaving behind white, powdery mineral deposits. This condition indicates that water from the exterior has penetrated into the building. Water damaged building materials such as GW and ceiling tiles can serve as a medium to support mold growth, especially if wetted repeatedly. These materials should be replaced after a water leak is discovered.

The US Environmental Protection Agency (EPA) and the American Conference of Governmental Industrial Hygienists (ACGIH) recommends that porous materials (e.g., GW and carpeting) be dried within 24 hours of becoming wet (US EPA, 2001; ACGIH, 1989). If drying is not done within this time frame, mold growth may occur. Water-damaged GW cannot be adequately cleaned to remove mold growth. The application of a mildewcide to GW is not recommended. Fungal microbial growth begins once water soaks porous materials. The fungus grows through its lifecycle, which produces spores. Dependent on the species of fungi, some spores are extremely buoyant and can be drawn into the ceiling plenum by operation of the ventilation system.

In order for building materials to support mold growth, a source of water exposure is necessary. Identification and elimination of water moistening building materials is necessary to control mold growth. Identification of GW with increased

moisture content over normal concentrations may indicate the possible presence of mold growth. Identification of the location of GW with increased moisture levels can also provide clues concerning the source of water supporting mold growth. Water content of the GW was measured by MDPH staff with a Delmhorst, BD-2000 Model, Moisture Detector with a Delmhorst Standard Probe. The BEHA assessment occurred on a day of moderate to heavy rainfall. No elevated moisture concentrations were measured in GW in this area, indicating that GW was not moistened at the time of the assessment. In addition, carpeting and ceiling tiles in this area did not have detectable moisture concentrations.

The most likely source of water penetration appeared to be junctions around an awning on the exterior wall outside of the library office (see Picture 11). Repair work to the exterior wall in this area was underway as evidenced by scaffolding and the sealing of the univent fresh air intake in this area (as shown in Picture 5). No information regarding the progress or purpose of repairs was available from school personnel.

Some areas of the peaked roof are not equipped with a gutter/downspout system (see Picture 12). Without such a system, rainwater can run down the side of the building and pool against the foundation. Picture 13 shows a trench with standing water along the perimeter of the building. Several gutters/downspouts were observed to be missing/damaged, which allowed rainwater to pool on the ground at the base of the building or against exterior walls (see Pictures 14 & 15). The freezing and thawing action of water during the winter months can create cracks and fissures in the foundation. Over time, this process can undermine the integrity of the building envelope.

Other areas that have had historic problems with water penetration are second floor classrooms with dormers. Dormers are structures that protrude from the flat plane of the roof to provide lighting and aesthetics. The construction of dormers, however is

complex and requires proper installation of adhesive membranes, roofing paper, taping of insulation around joints and flashing to prevent water penetration and damage to porous building materials. Water staining and efflorescence was noted in classrooms equipped with dormers, which may indicate water leakage through flashing. Picture 16, shows dark staining on GW indicating possible mold growth. No elevated moisture concentration was measured in water damaged GW.

Several classrooms had a number of plants. Moistened plant soil and drip pans can be a source of mold growth. The lack of drip pans can lead to water pooling and mold growth on windowsills. Plants are also a source of pollen. Plants in several classrooms were noted near univent air diffusers. Plants should be located away from the air stream of ventilation sources to prevent the aerosolization of mold, pollen or particulate matter throughout the classroom.

Other Concerns

Several other conditions were noted during the assessment, which can affect indoor air quality. Cleaning products and other unlabeled materials were found on counter-tops and beneath sinks in a number of classrooms (see Picture 17). Products should be kept in their original containers or be clearly labeled as to their contents, for identification purposes in the event of an emergency. The scent of deodorizer was detected upon entry into classrooms 103 and 123. The sources of the odors were identified as a plug-in air freshener in classroom 123 and a Christmas tree-type air freshener on top of the univent air diffuser in classroom 103. Also noted were at least four or five of the same type of air fresheners inside the fan housing of the unit (see Picture 18). Air fresheners and cleaning products contain chemicals that can be irritating

to the eyes, nose and throat of sensitive individuals. Further, air fresheners do not remove materials causing odors, but rather mask odors which may be present in the area.

Also of note was the amount of materials stored inside classrooms. In classrooms throughout the school, items were observed to be piled on windowsills, tabletops, counters, bookcases and desks. The large number of items stored in classrooms provide a source for dusts to accumulate. These items, (e.g., papers, folders, boxes, etc.) make it difficult for custodial staff to clean. Dust can be irritating to eyes, nose and respiratory tract. Items should be relocated and/or be cleaned periodically to avoid excessive dust build up. A number of exhaust vents in classrooms, restrooms and in the gymnasium were noted with accumulated dust (see Picture 19). If exhaust vents are not functioning, backdrafting can occur, which can re-aerosolize dust particles. In addition, these materials can accumulate on flat surfaces (e.g., desktops, shelving and carpets) in occupied areas and subsequently be re-aerosolized causing further irritation.

BEHA staff inspected filters for classroom univents and found the filter in the music room coated with up to a half inch of dirt/dust and accumulated material (see Picture 20). A debris-saturated filter can obstruct airflow and may serve as a reservoir of particulates that can be re-aerosolized and distributed to occupied areas via the ventilation system.

Several classrooms contained dry erase boards and dry erase markers. Materials such as dry erase markers and dry erase board cleaners may contain VOCs, (e.g. methyl isobutyl ketone, n-butyl acetate and butyl-cellusolve) (Sanford, 1999), which can be irritating to the eyes, nose and throat. Accumulated chalk dust was noted in several classrooms. Chalk dust is a fine particulate, which can be easily aerosolized and is an eye and respiratory irritant. Several areas had missing ceiling tiles. Missing ceiling tiles

can provide an egress for dirt, dust and particulate matter into occupied areas. These materials can also be irritating for certain individuals.

Several areas have lamination machines and/or photocopiers. Lamination machines give off odors. Volatile organic compounds (VOCs) and ozone can be produced by photocopiers, particularly if the equipment is older and in frequent use. Ozone is a respiratory irritant (Schmidt Etkin, D., 1992). School personnel should ensure that local exhaust ventilation is activated while equipment is in use to help reduce excess heat and odors in these areas.

A flammable storage cabinet was found in the art storage room (129). This cabinet was vented to the outside by ductwork (see Picture 21). The NFPA does not require venting in flammable storage cabinets. However, it is recommended that if a flammables storage cabinet is connected to a vent system, the vent system should not be constructed in a manner to provide an oxygen source to the interior of the cabinet and it must be vented directly outdoors and not in a manner which might compromise the specific performance of the cabinet (NFPA, 1996). The mechanical exhaust fan was not functioning during the assessment, allowing backdrafting into the cabinet. BEHA staff also noted chemical odors upon opening the cabinet, likely emanating from spilt materials and/or improperly secured containers (see Picture 22). Chemicals used in art (e.g., spray paints, fixatives) often contain VOCs, which can result in odors, irritant symptoms in the eyes, nose and throat, and are a potential fire hazard.

A bee/hornet's nest was observed along the perimeter of the building (see Picture 23). Evidence of bird roosting was also noted outside the building in the form of nesting materials and accumulated bird wastes in a vent along the front of the building (see Picture 24). Due to the height and limited interior access to this vent, BEHA staff were not able to determine if the vent was sealed. If open, this vent can provide a means of

egress for birds and associated wastes/odors into the building. Birds can be a source of disease, and bird wastes and feathers can contain mold and mildew, which can be irritating to the respiratory system.

As mentioned previously, mechanical exhaust ventilation in restrooms was not functioning during the assessment. Exhaust ventilation is necessary in restrooms to remove moisture and to prevent restroom odors from penetrating into adjacent areas.

Along the perimeter of the building, shrubbery and flowering plants were noted in close proximity to a univent fresh air intake outside of one of the classrooms (see Picture 2). Shrubbery and flowering plants can be a source of mold and pollen and should be placed and/or maintained to ensure that fresh air intakes remain clear of obstructions.

Conclusions/Recommendations

The conditions found in the Halifax Elementary School present a number of problems that require a series of remedial steps. For this reason a two-phase approach is required, consisting of immediate (**short-term**) measures to improve air quality within the school and **long-term** measures that will require planning and resources to adequately address overall indoor air quality concerns.

In view of the findings at the time of this assessment, the following **short-term** recommendations are made:

1. Work with the Silver Lake Regional School District to develop a preventative maintenance program for all HVAC equipment.
2. Change filters for air-handling equipment as per the manufacturer's instructions or more frequently if needed. Clean out interiors of univents and AHUs during each filter change.

3. Examine each univent for function. Survey classrooms for univent function to ascertain if an adequate air supply exists for each room. Consider consulting a heating, ventilation and air conditioning (HVAC) engineer concerning the calibration of univent fresh air control dampers school-wide.
4. Restore exhaust ventilation in classrooms and restrooms to working order. Examine rooftop exhaust motors for proper function; repair and replace parts as needed.
5. To maximize air exchange, the BEHA recommends that both supply and exhaust ventilation operate continuously during periods of school occupancy independent of classroom thermostat control.
6. Remove all blockages from univents and exhaust ventilators to ensure adequate airflow. Remove/relocate end coat hook in classrooms nearest to wall-mounted exhaust vent (see Picture 25) to prevent blockage.
7. Once both the fresh air supply and the exhaust ventilation are functioning properly, the system should be balanced every five years by an HVAC engineering firm.
8. For buildings in New England, periods of low relative humidity during the winter are often unavoidable. Therefore, scrupulous cleaning practices should be adopted to minimize common indoor air contaminants whose irritant effects can be enhanced when the relative humidity is low. To control for dusts, a HEPA filter equipped vacuum cleaner in conjunction with wet wiping of all non-porous surfaces is recommended. Drinking water during the day can help ease some symptoms associated with a dry environment (throat and sinus irritations).
9. Repair and/or replace thermostats as necessary to maintain control of comfort.

10. Keep plants away from univents in classrooms. Ensure plants have drip pans, examine drip pans for mold growth and disinfect areas with an appropriate antimicrobial where necessary.

11. Replace any remaining water-stained ceiling tiles, GW and pipe insulation. Examine the areas above and around these areas for microbial growth. Inspect wallboard for water-damage and mold/mildew growth, repair/replace as necessary. Disinfect areas of microbial growth with an appropriate antimicrobial as needed.

12. Replace/repair damaged downspouts and install elbows in a manner to direct rainwater away from the building.

13. Inspect plant growth outside perimeter of building periodically; trim plants away from fresh air intakes as needed.

14. Store cleaning products and chemicals properly and keep out of reach of students.

15. Relocate or consider reducing the amount of materials stored in classrooms to allow for more thorough cleaning of classrooms. Clean items regularly with a wet cloth or sponge to prevent excessive dust build-up.

16. Ensure exhaust ventilation is functioning in areas that contain lamination machines and photocopiers.

17. Refrain from using strong scented materials (e.g., air fresheners) in classrooms.

18. Clean chalkboards and trays regularly to prevent the build-up of excessive chalk dust.

19. Replace missing/damaged ceiling tiles.

20. Either restore local mechanical exhaust ventilation to flammable storage cabinet in art storage room or consider removing ductwork and sealing hole to render cabinet airtight.

21. Have a chemical inventory done in all storage areas and classrooms. Discard hazardous materials or empty containers of hazardous materials in a manner consistent with environmental statutes and regulations. Follow proper procedures for storing and securing hazardous materials. Obtain Material Safety Data Sheets (MSDS') for chemicals from manufacturers or suppliers.

22. Remove bees/hornet's nest and bird's nest from exterior of building in a manner as to not introduce insects, pesticides or bird wastes into the building. Consider installing screens around vent in Picture 25 to prevent the reoccupation of birds.

The following **long-term** measures should be considered:

1. Examine the feasibility of installing a gutter/downspout system to parts of the building that lack them.
2. Consult with architect and or general contractor regarding the integrity of the building envelope, primarily concerning water damage to interior building materials and potential microbial growth due to water penetration issues around dormers and awnings.
3. Consider installing ductwork and air diffusers on cafeteria AHU to ensure proper airflow and distribution.

References

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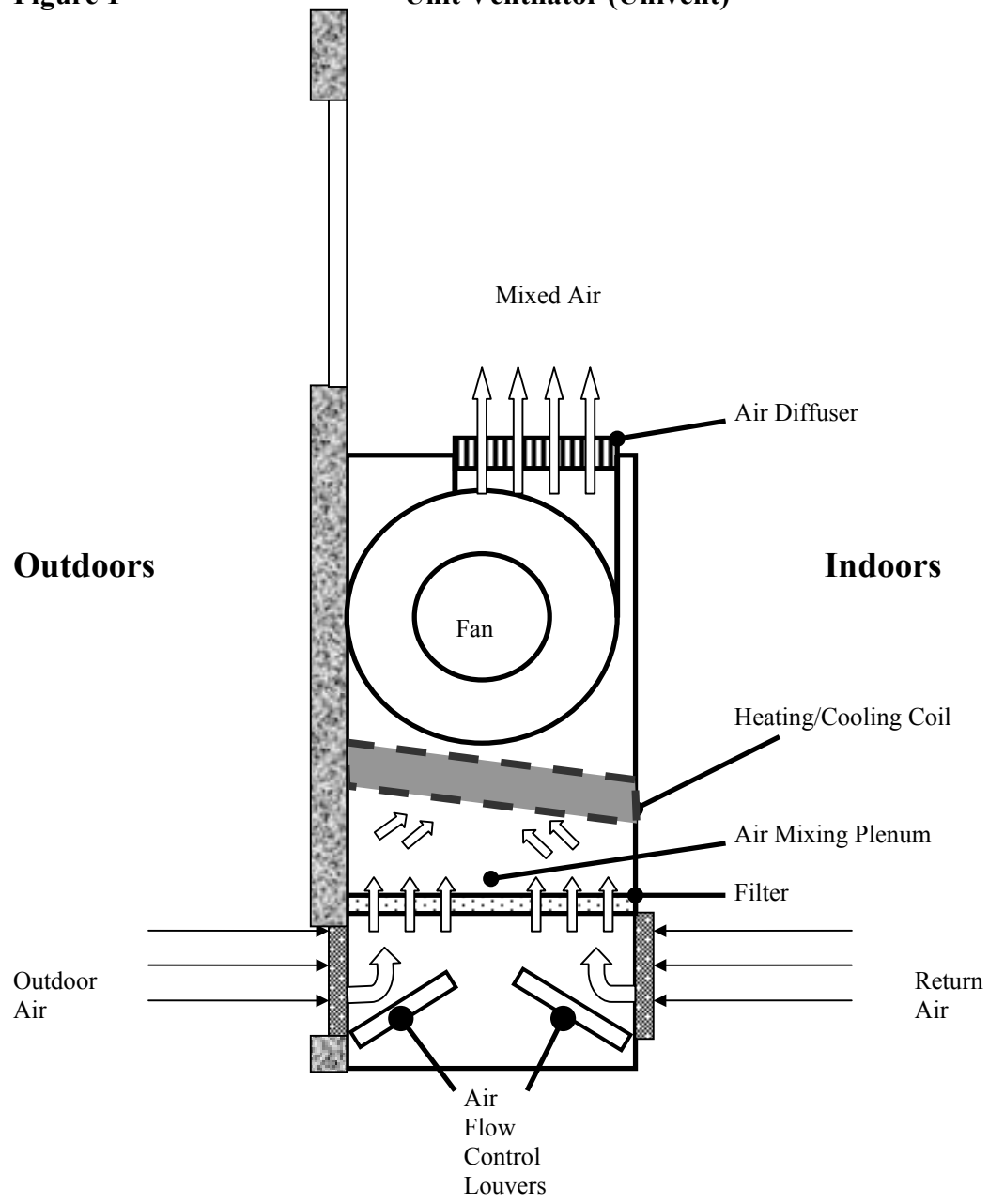
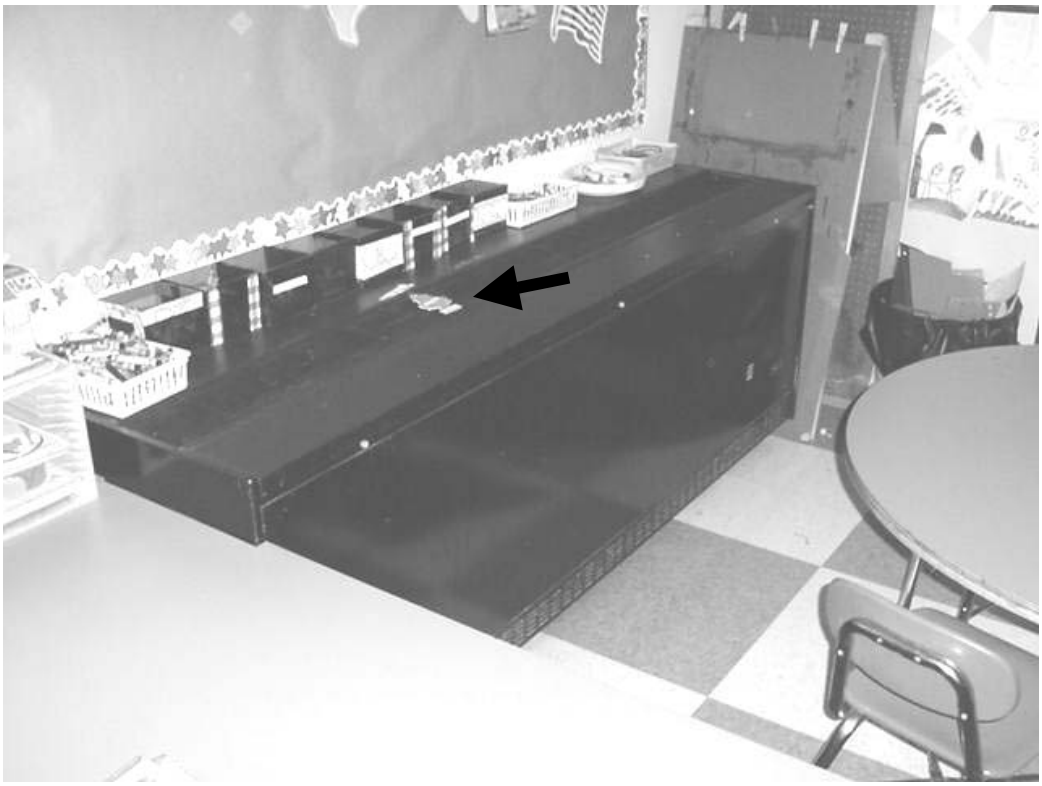
Figure 1 **Unit Ventilator (Univent)**



Picture 1

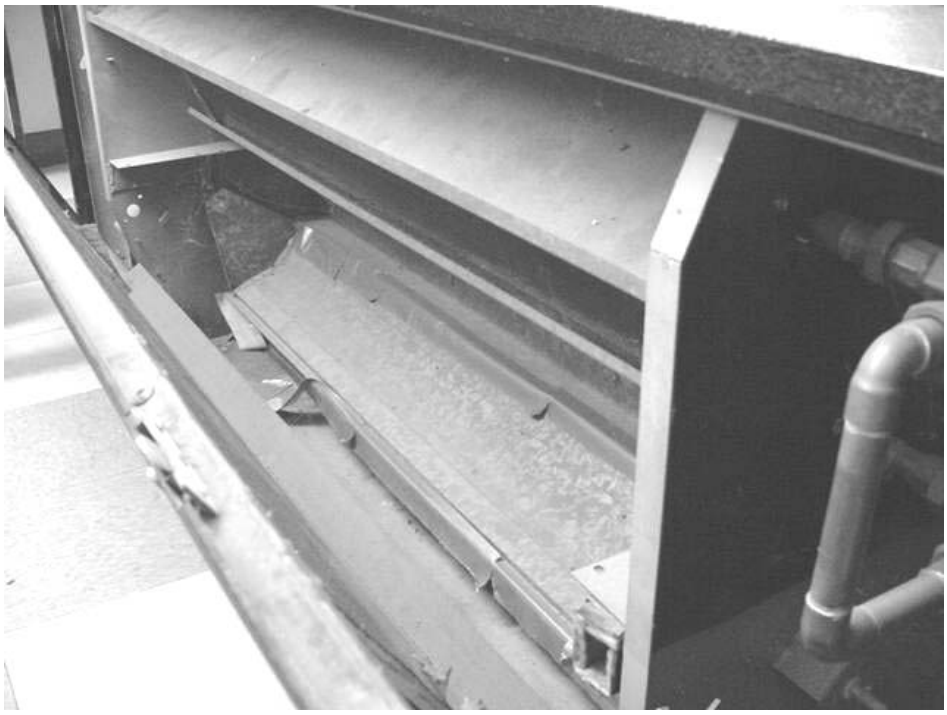


Classroom Unit Ventilator (Univent)
Note Christmas Tree Air Freshener on Air Diffuser

Picture 2

Univent Fresh Air Intake, Note Close Proximity of Shrubbery

Picture 3



Interior of Univent Missing Fans and Associated Mechanical Components in Classroom 115

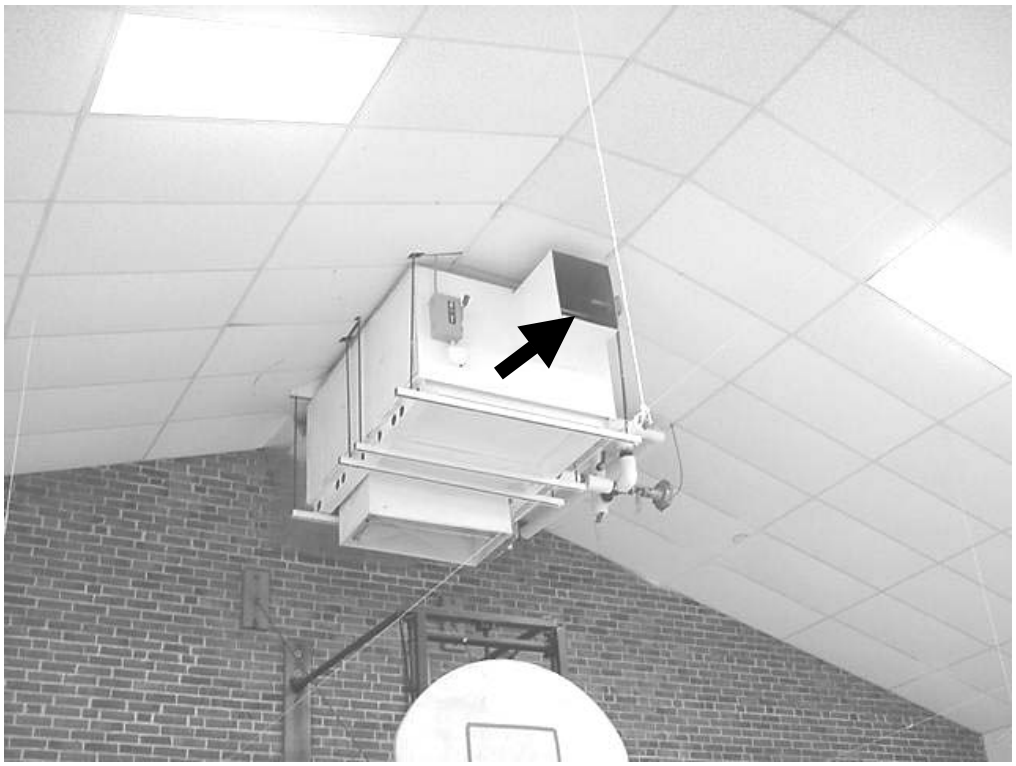
Picture 4

Univent Air Diffuser (top) Obstructed by Books & Papers;
Univent Return Vent (along front base of unit) Blocked by File Cabinet

Picture 5

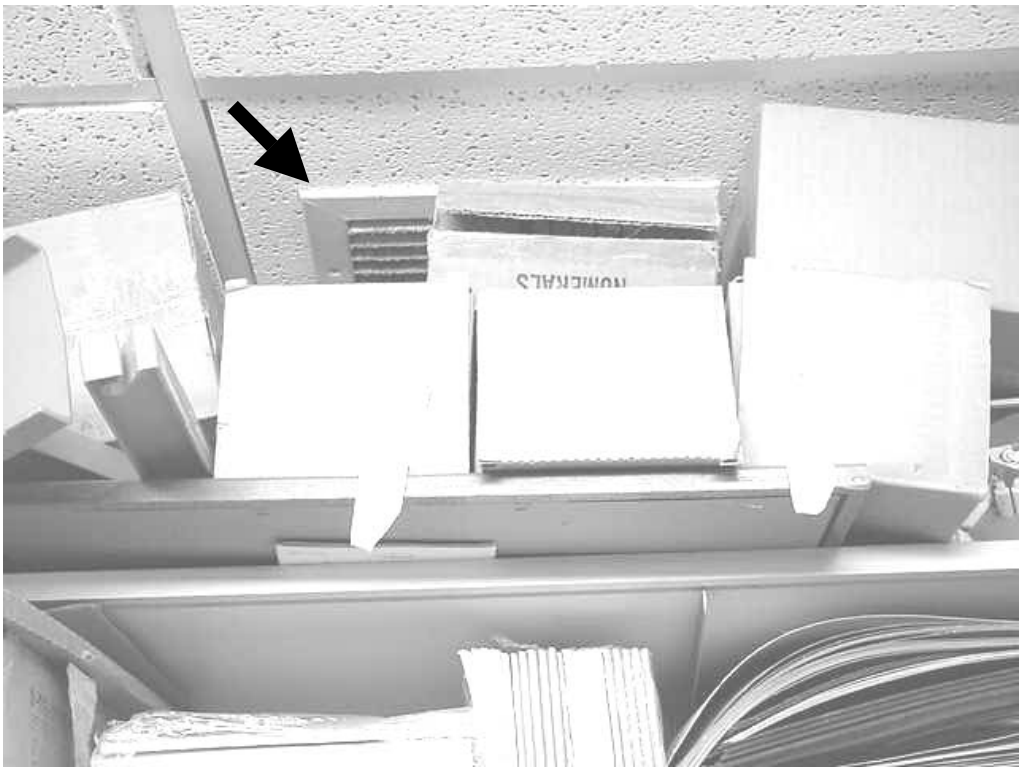
Univent Fresh Air Intake Covered With Plywood

Picture 6



Ceiling-Mounted Air Diffuser in Cafeteria Missing Ductwork

Picture 7



Coat Closet Exhaust Vent Obstructed by Boxes

Picture 8

Wall-Mounted Exhaust Vent Obstructed by Boxes

Picture 9

Missing/Water-Damaged Ceiling Tiles in Library Office

Picture 10

Close-up of Water Damaged Wallboard/Efflorescence in the Library Office

Picture 11

Awning Directly Outside of Library Office, Also Note Broken Window

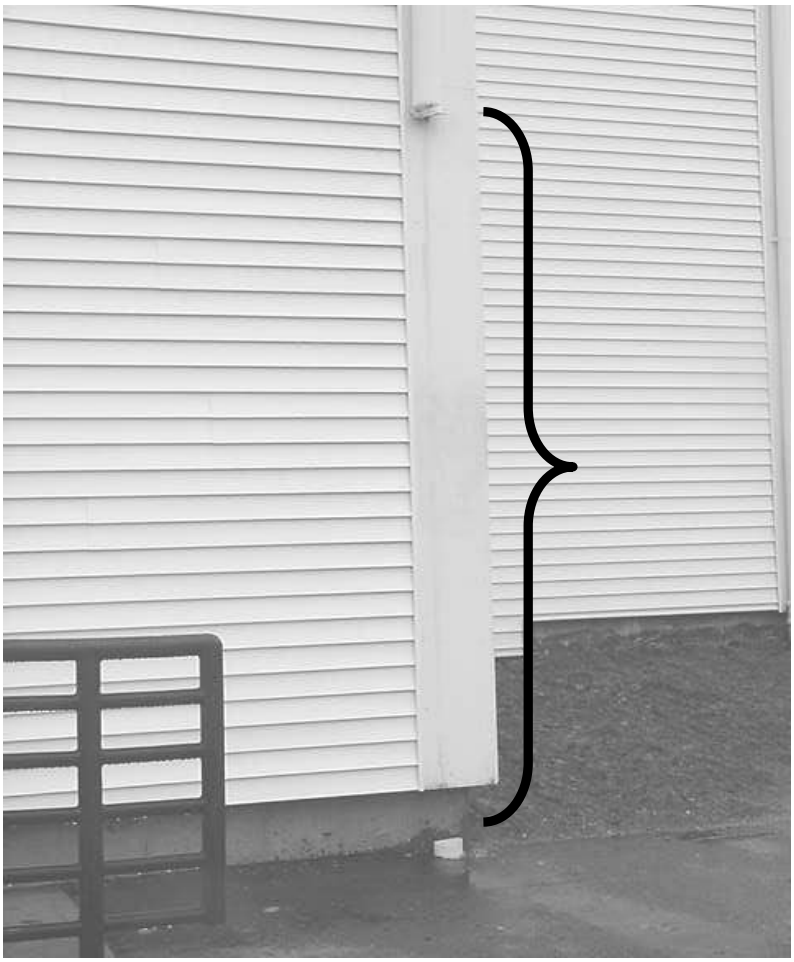
Picture 12

Portion of Building Not Equipped with Gutters/Downspouts

Picture 13

Trench along Building Note Standing Water against Foundation

Picture 14

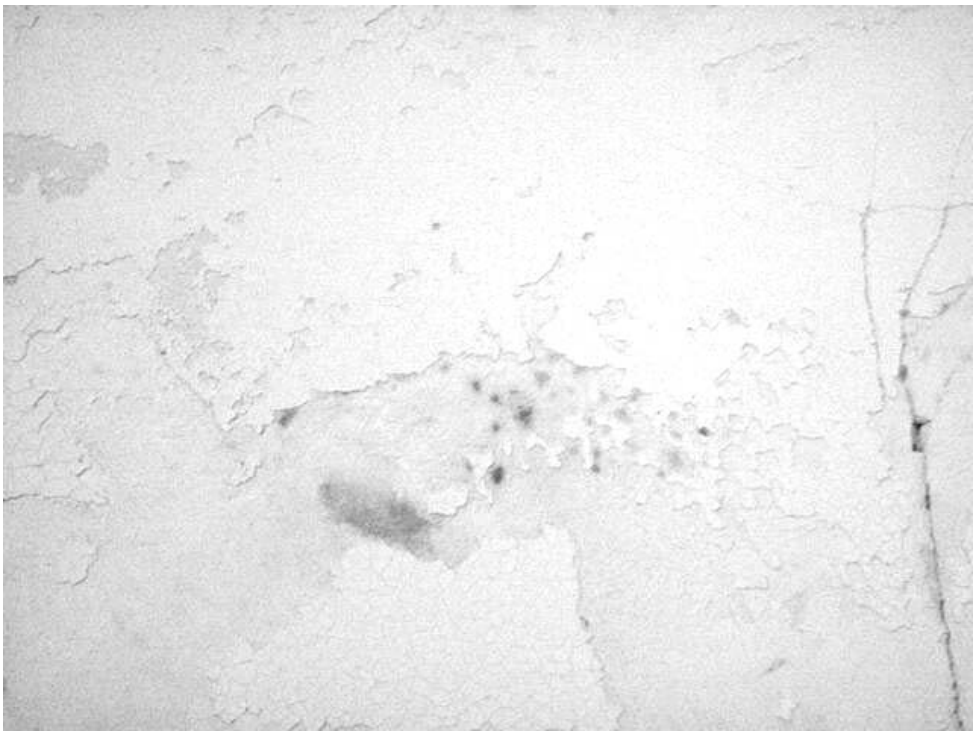


Missing/Damaged Downspout

Picture 15

Downspout Directing Water *Toward* Instead of Away From the Building

Picture 16

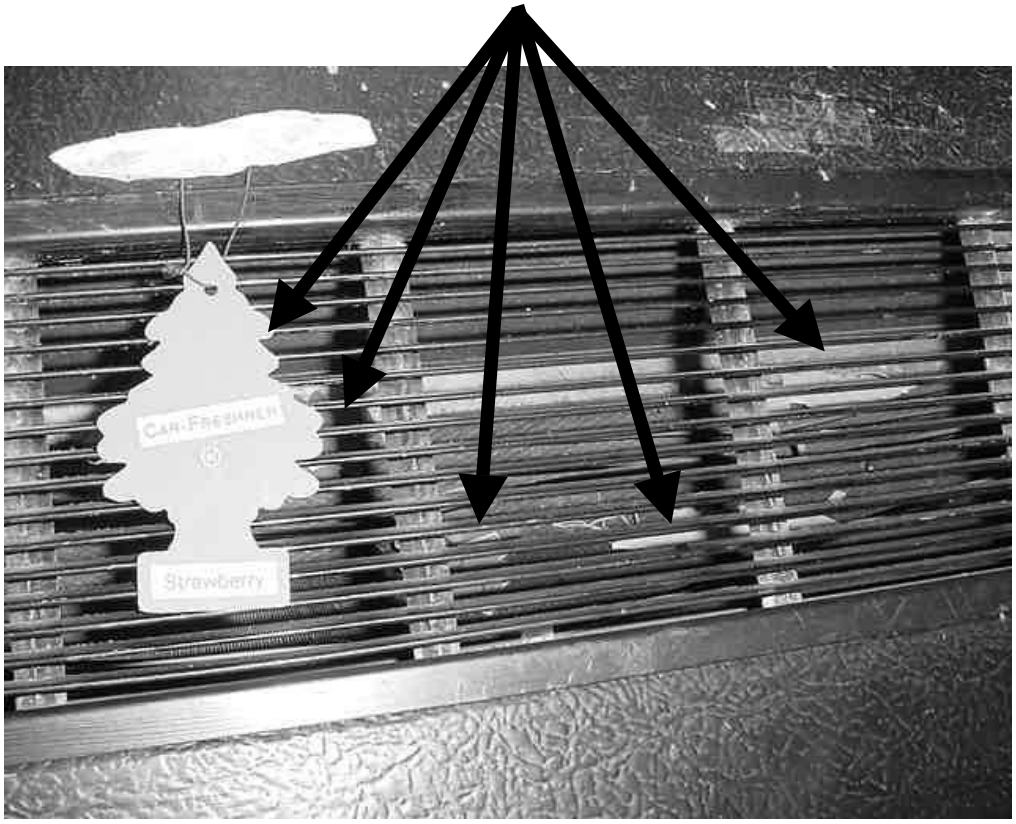


Water Damage and Peeling Paint in Classroom 203;
Dark Staining Indicates Possible Mold Growth

Picture 17

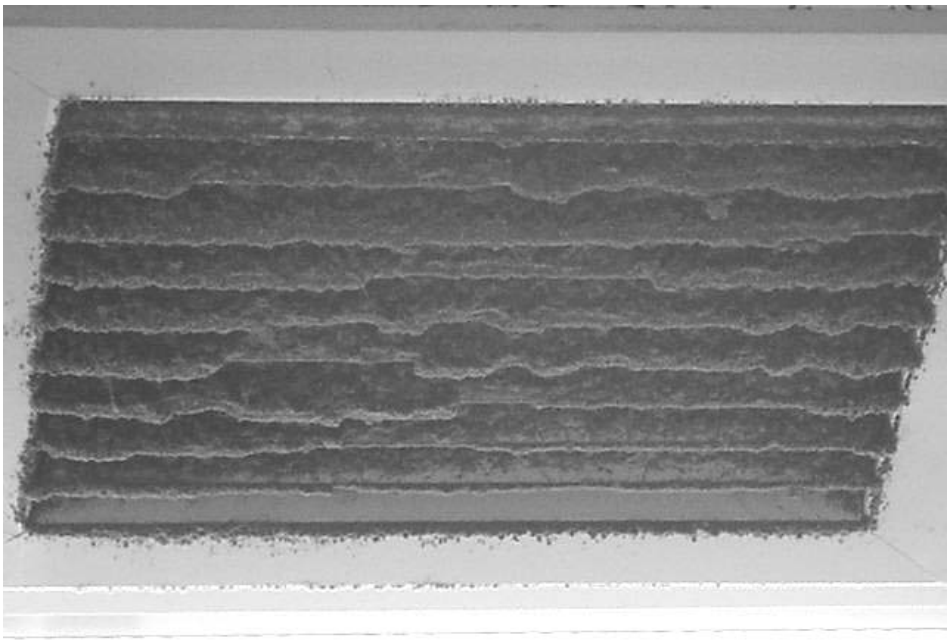
Cleaning Products and Other Materials in Unlocked Cabinet below Classroom Sink

Picture 18



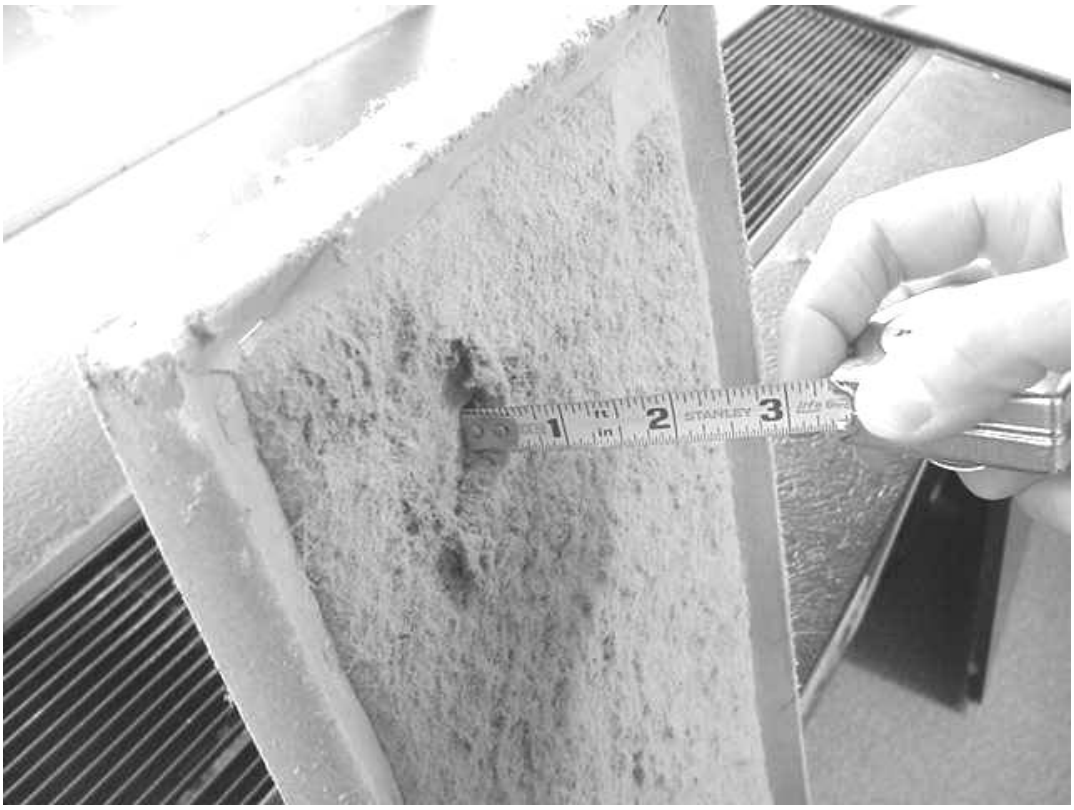
Air Fresheners on and Inside Univent Air Diffuser

Picture 19



Accumulated Dust/Debris on Exhaust Vent

Picture 20



Univent Filter in Music Room Coated with Dirt & Debris

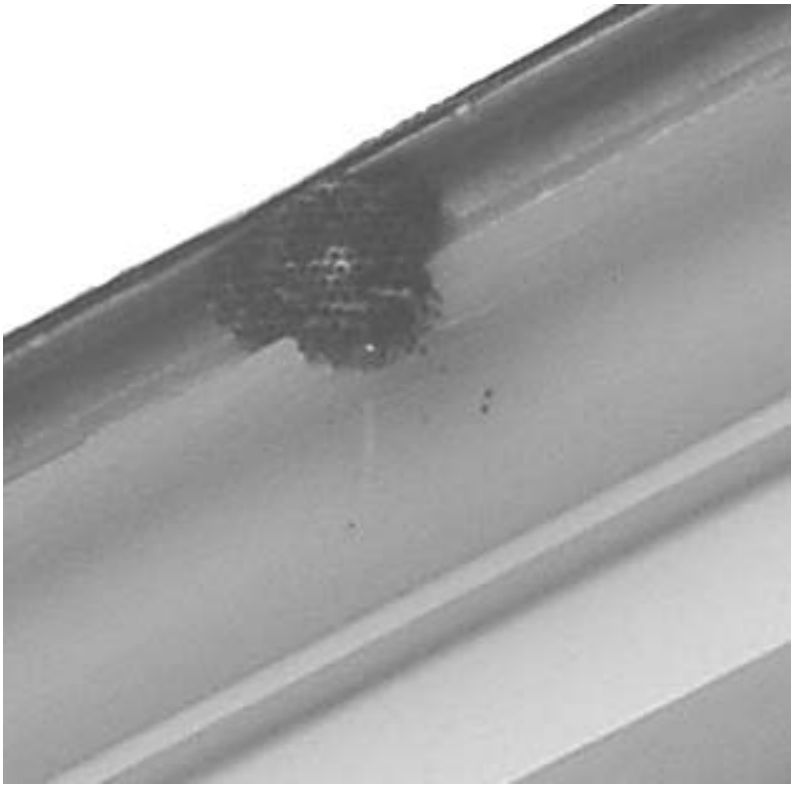
Picture 21

Ducted Flammables Cabinet in Art Storeroom (129)

Picture 22

Close-up of Container of Rubber Cement, Note Cap not Fully Secured and Material Leaked Out

Picture 23



Bee/Hornets Nest Along Perimeter of Building

Picture 24

Nesting Materials and Bird Wastes

Picture 25

Coats Blocking Airflow to Exhaust Vent

TABLE 1

Indoor Air Test Results – Halifax Elementary School, Halifax, MA – January 11, 2002

Remarks	Carbon Dioxide *ppm	Temp. °F	Relative Humidity %	Occupants in Room	Windows Openable	Ventilation		Remarks
						Intake	Exhaust	
Outside (Background)	375	51	67					Weather conditions: cold, light rain, overcast
Room 101	726	71	34	17	Yes	Yes	Yes	Cleaning product/bleach under sink, Ceiling tile ajar, bathroom
Room 102	764	71	34	17	Yes	Yes	Yes	Bathroom door open, items under sink-bleach/unlabeled materials
Room 103	741	72	31	16	Yes	Yes	Yes	Air fresheners in/on univent
Room 104	749	72	30	19	Yes	Yes	Yes	
Room 105	682	69	32	9	Yes	Yes	Yes	Classroom Exhaust off Bathroom Exhaust not functioning Short Circuiting
Auditorium	501	69	30	2	Yes	Yes	Yes	6 water damaged CT along wall/ceiling jct.
Cafeteria	1048	71	37	~100	Yes	Yes	Yes	Ceiling Mtd AHU-Not ducted, 1 water damaged CT, between lunches
Room 129 (Art Room)	1580	72	33	~20	Yes	Yes	Yes	Univent off-deactivated/heat issues, dust accumulation on exhaust vent

*** ppm = parts per million parts of air**
CT = water-damaged ceiling tiles

Comfort Guidelines

Carbon Dioxide -	< 600 ppm = preferred
	600 - 800 ppm = acceptable
	> 800 ppm = indicative of ventilation problems
Temperature -	70 - 78 °F
Relative Humidity -	40 - 60%

TABLE 2

Indoor Air Test Results – Halifax Elementary School, Halifax, MA – January 11, 2002

Remarks	Carbon Dioxide *ppm	Temp. °F	Relative Humidity %	Occupants in Room	Windows Openable	Ventilation		Remarks
						Intake	Exhaust	
Storage Room (Art)					Yes	Yes	Yes	Ducted exhaust-off, flammable cabinet-backdraft, materials not secured, passive air intake (door), shellacs, rubber cement, inks sprays, heater in space
Room 130	810	77	19	1	Yes	Yes	Yes	Exhaust-off/backdrafting, univent filter accumulated with dust (~½ inch)
Gym	576	70	28	17	No	Yes	Yes	Vent off
Room 128	1583	75	36	20	Yes	Yes	Yes	Items on univent Exhaust vent blocked w/ boxes
Room 126	660	81	28	17	Yes	Yes	Yes	Heat complaints Door and window open
Room 127	780	74	28	1	Yes	Yes	Yes	(18) Occupants gone 20 min prior for indoor recess, window open
Room 124	650	72	30	0	Yes	Yes	No	Items on univent, accumulated items
Room 125	1179	74	30	1	Yes	Yes	Yes	Items on univent, univent off (fuse), door open, items in front of hall table, exhaust vent partly blocked
Room 123	765	71	31	23	Yes	Yes	Yes	Strong chemical odor (vanilla) from plug in air freshener

*** ppm = parts per million parts of air**
CT = water-damaged ceiling tiles

Comfort Guidelines

Carbon Dioxide -	< 600 ppm = preferred
	600 - 800 ppm = acceptable
	> 800 ppm = indicative of ventilation problems
Temperature -	70 - 78 °F
Relative Humidity -	40 - 60%

TABLE 3

Indoor Air Test Results – Halifax Elementary School, Halifax, MA – January 11, 2002

Remarks	Carbon Dioxide *ppm	Temp. °F	Relative Humidity %	Occupants in Room	Windows Openable	Ventilation		Remarks
						Intake	Exhaust	
Room 121	1810	72	37	20	Yes	Yes	Yes	Univent and Exhaust off
Room 122	1700	72	37	22	Yes	Yes	Yes	Heat extremes, univent off-deactivated due to heat, door open
Room 208	1320	72	34	21	Yes	Yes	Yes	Univent off, items on/in front of univent, door open
Room 207	1476	72	35	17	Yes	Yes	Yes	Items on/in front of univent Chalk dust
Room 206	1222	71	33	21	Yes	Yes	Yes	Cleaning product on sink countertop, univent covered with items
Room 205	760	72	32	19	Yes	Yes	Yes	Items on univent, peeling paint in dormer corner, historic water damage-fixed, door open
Conference Room A	1070	73	32	1	No	No	Yes	
Room 204	1338	74	33	20	Yes	Yes	Yes	Exhaust off, CT ajar, door open
Room 203	1077	75	32	18	Yes	Yes	Yes	peeling paint/water damage-wall & along base boards, water damaged wall plaster-dormer, possible mold growth/staining, door open

*** ppm = parts per million parts of air**
CT = water-damaged ceiling tiles

Comfort Guidelines

Carbon Dioxide -	< 600 ppm = preferred
	600 - 800 ppm = acceptable
	> 800 ppm = indicative of ventilation problems
Temperature -	70 - 78 °F
Relative Humidity -	40 - 60%

TABLE 4

Indoor Air Test Results – Halifax Elementary School, Halifax, MA – January 11, 2002

Remarks	Carbon Dioxide *ppm	Temp. °F	Relative Humidity %	Occupants in Room	Windows Openable	Ventilation		Remarks
						Intake	Exhaust	
Room 114	1369	73	33	22	Yes	Yes	Yes	Univent off, items on univent
Room 115	1076	71	30	1	Yes	Yes	Yes	Univent off, table full of plants near univent, univent reportedly had component removed, chalk dust
Library					Yes	Yes	Yes	Plumbing leak, no existing water damage/stains, no lingering odors, problems corrected
Library Office	566	67	51	0		No	No	Water damaged/missing CT, water damage/efflorescence-wall, periodic leaks from building envelope, scaffolding outside, musty odors Moisture content in CT=6.9% Moisture content in wall=6.9% (dry)

*** ppm = parts per million parts of air**
CT = water-damaged ceiling tiles

Comfort Guidelines

Carbon Dioxide -	< 600 ppm = preferred
	600 - 800 ppm = acceptable
	> 800 ppm = indicative of ventilation problems
Temperature -	70 - 78 °F
Relative Humidity -	40 - 60%